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**TECHNICAL MANUAL**

**INSTRUCTION GUIDE**

**BINAURAL TRAINING INSTRUMENT  
M2**

November 21, 1941





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WAR DEPARTMENT,  
 WASHINGTON, November 21, 1941.

## INSTRUCTION GUIDE

# BINAURAL TRAINING INSTRUMENT M2

Prepared under direction of the  
 Chief of Ordnance

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**1. General.**—*a. Purpose.*—This manual is published for the information of both the using arms and services and ordnance maintenance personnel.

*b. Scope.*—This manual covers the underlying theory of the binaural training instrument M2, a detailed description of its parts, complete operating instructions, and necessary care and maintenance. Maintenance operations described may be performed by using arms personnel.

*c. References.*—The appendix lists the publications pertaining to the equipment described herein.

**2. Function and use.**—*a.* The binaural training instrument M2 is a device for determining the accuracy of a listener's binaural perception and for selecting and training listeners for the operation of sound locators.

*b.* The inclusion of an amplifier and horn in the transcription unit permits the use of the unit as a remote source of sound for sound locator practice. This feature constitutes the principal difference between this equipment and the binaural training instrument M1.

*c.* The instrument is designed to reproduce the conditions experienced in the operation of sound locators insofar as the binaural phase balance is concerned.

\*This manual supersedes TM 9-2662, January 27, 1941.

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**3. Description.**—*a.* The instrument consists of a transcription unit which reproduces phonographic records of aircraft in flight, a binaural phase control unit which varies the length of the sound paths to the ears of the listener, and a helmet for the use of the listener.

*b.* A numerical scale on the phase control unit reads directly in degrees of error from the exact binaural balance.

**4. Operation.**—*a. Theory.*—(1) *General.*—(*a*) Sound is a wave motion propagated in all directions from the sound source at the rate, in air, of approximately 1,100 feet per second. Unless the listener is facing in the direction of the sound source, the sound wave will impinge upon the diaphragm of one ear a fraction of a second sooner than upon that of the other ear, with the result that the listener is aware that the sound source is at an angle to his right or left. If the listener turns his head the proper amount, the sound wave strikes both ears simultaneously and is analyzed as coming from the front.

(*b*) This same effect may be accomplished by splitting the sound from a single source into two paths of unequal length which terminate at the ears of the listener. As before, the sound wave will strike one ear before the other, with the effect that the sound will appear to be coming from a point to the right or left of the listener. If provision is made for varying the relative lengths of the sound paths, the listener can cause the sound to emanate apparently from a point on or to the right or left of the median line. This principle is used in the binaural training instrument M2 to simulate the conditions encountered in the actual operation of the sound locator.

(2) *Binaural sense.*—The ability of the ears and brain to determine the direction of a sound source is called the binaural sense and is dependent upon the binaural phase effect and the binaural intensity effect.

(*a*) *Binaural phase effect.*—This effect, which is produced by the difference in the time of arrival of a sound wave or phase at the two ears, enables the listener to determine the angular displacement of the sound source from the median line. The binaural phase effect is useful only in locating sounds of less than 1,300 cycles per second frequency. Above this frequency the effect ceases for most people although it has been found that some observers, after considerable experience, can extend this range to several thousand cycles.

(*b*) *Binaural intensity effect.*—This effect predominates at frequencies above 1,300 cycles and is due to the difference in the intensities of the sound at the two ears. The listener turns his head until the

sound waves strike both ears with equal intensity, at which instant the sound will be analyzed as coming from the front. This effect, however, is not believed to be particularly effective in the making of accurate directional determinations.

*b. Procedure.*—(1) *Selection of listeners.*—(a) Experience indicates that the best listeners come from the group having the highest degree of education and intelligence. Individuals with subnormal hearing in one or both ears should not be employed in sound locator work. Every effort should be made to keep the listener free from distraction or fatigue caused by cramped positions and uncomfortable weather conditions.

(b) It is essential that only willing listeners and men sympathetic to the problem are employed. Further, their interest must be stimulated and maintained throughout the training period by resorting to competition, team accuracy tests, and other similar devices. Close concentration and application will result in a surprising increase in accuracy in the space of a few weeks.

(2) *Training of listeners.*—(a) *General.*

1. At the beginning a listener should be trained for short periods of time, not to exceed 15 minutes at any one time. These periods may be lengthened, as training progresses, to a maximum of 30 minutes continuous centering or 1 hour of intermittent setting. Experience shows that a marked decrease in accuracy, even with highly trained listeners, will occur if these periods are exceeded.
2. The use of a blindfold will be found to be of material benefit in assisting the listener to concentrate on the problem.
3. Instruction should be divided into two stages consisting of preliminary or elementary training with the transcription and phase control units and advanced training with the sound locator and the transcription unit.

(b) *Preliminary.*—The listener should first attempt to compensate for fixed displacements set into the mechanical phase control unit by the instructor, oscillating back and forth across the binaural center until an exact balance is obtained. After becoming proficient in locating the exact center, the student should be trained to follow continuously displacements set in by the instructor. With sufficient training the listener should be able to locate and follow the center without resorting to oscillations across the center. The listener should then be taught to recognize the various types of aircraft by their characteristic sounds, enabling him to distinguish a multiple-motored bomber from other types such as pursuit and observation. The



fourth phase of primary training consists of practice in operating the phase control unit against a background of distracting noise such as an electric fan or a motor.

(c) *Advanced.*—During the advance stages of instruction the horn is connected to the amplifier and the phase control unit is disconnected. The horn should be suspended from a horizontal wire at a distance as far as practicable from the sound locator. The student, blindfolded, should first be trained to locate accurately the horn with the sound locator when the horn is held in a fixed position. After attaining proficiency in this phase of training, the listener should practice the operation of smoothly following the course of the horn as it is moved along its supporting wire.

**5. Major units.**—The binaural training instrument M2 is composed of the following principal units:

Transcription unit (figs. 2, 14, and 15).

Phase control unit (figs. 6 to 9, incl., 12, and 13).

Helmet assembly (figs. 10, 12, and 13).

**6. Transcription unit.**—*a.* The transcription equipment is housed within the metal chest (fig. 11), and consists essentially of the motor-driven turntable (2, fig. 14) and the magnetic pick-up (3), the amplifier assembly (fig. 4), and the horn (fig. 15).

*b.* The turntable is driven at a speed of 78 rpm by a 115-volt, 60-cycle, a-c motor which is controlled by the toggle switch (5, fig. 14).

*c.* The cable (6, fig. 14) connects the transcription unit to the power source. (See wiring diagram, fig. 16.)

*d.* The pick-up (3, fig. 14) carries a needle which makes mechanical contact with the groove in the record. The vibration of the needle produces, by means of an electromagnetic circuit, an oscillating voltage which is a reproduction of the undulating record groove. This oscillation is transmitted through the amplifier (C70344, fig. 4) to either the horn or the receiver (figs. 15 and 13, respectively).

*e.* The amplifier is furnished with a volume control (8, fig. 14) which permits adjustment of the volume to the required level when using either the horn or the receiver.

*f.* The horn may be connected to the amplifier by means of the cable (fig. 15) and the plug (9, fig. 14) operating through the contact rings (7) and the shorter cable (10). The hanger (fig. 15) is provided for the purpose of suspending the horn from a horizontal wire or cable in order to provide a moving target for sound locator practice. The cable is of sufficient length to permit the location of the horn at a distance of 300 feet from the transcription unit, and is provided with a crank (fig. 15) for rewinding.

g. The unit is provided with a 5-ampere fuse which can be removed by means of the extractor fuse post (1, fig. 14).

**7. Phase control unit.**—*a.* The mechanical phase control mechanism is inclosed within the box (fig. 11). The cable is plugged into the phone jack which is connected to the receiver (fig. 13), and into a similar jack (4, fig. 14) in the amplifier contained in the transcription unit.

*b.* The sound emanating from the receiver is split into two paths by the wye (fig. 13) and is transmitted to the earpieces in the helmet through the tubes (B129351, fig. 7), the trombone slides (C44602, fig. 8), and the rubber tubes (fig. 12).

*c.* The lengths of the two sound paths may be varied by movement of the trombone slides (C44602) which are mutually connected through a differential driven by the handwheels (fig. 12). A movement of either slide will cause the other slide to move an equal distance in the opposite direction, and the motion of the two slides is the resultant of the motion of one or both handwheels. The instructor causes an unbalanced condition by rotating the instructor's handwheel, and the student may continuously compensate for the unbalanced condition by rotating student's handwheel. The student's handwheel is of the size and type used on the sound locator.

*d.* The pointer and the scale (fig. 12) indicate the angular degrees of error from the exact binaural balance.

*e.* Friction clutches (secs. F-F and G-G, fig. 9) are mounted on the handwheel shafts (A38809 and A38808, fig. 8) to prevent damage to the pointer, which would otherwise result from excessive movement of the trombone slides.

**8. Helmet assembly.**—*a.* Two Signal Corps type HA1 helmets (fig. 12), one large and one small, are modified to adapt them to this use. They are equipped with soft rubber earpieces (fig. 10) which fit over the listener's ears and a chin strap to hold them snugly against his head.

*b.* The rubber tubes fit over metal receivers (fig. 10) on which the earpieces are mounted, forming the terminals of the sound paths.

**9. Care and preservation.**—*a. Needle and pick-up.*—(1) The needle should be firmly seated in its socket in the pick-up arm. Do not attempt to adjust or relocate the needle after it has once been used to play a record and do not reinsert a used needle that has been removed from the pick-up.

(2) Place the needle gently on the record only after the turntable has gained its correct speed.

(3) Do not leave the pick-up in contact with the turntable when not in use.

*b. Lubrication.*—(1) Remove the turntable and lubricate the armature bearings sparingly with light oil once every 6 months.

(2) Keep the contact rings and springs on the cable reel free from oil and dirt.

(3) The gears, bearings, and slides in the phase control unit should be lubricated with oil, lubricating, for aircraft instruments and machine guns, to insure smooth and quiet operation.

(4) Subsequent Ordnance Field Service bulletins governing the lubrication of fire-control instruments should be consulted for supplementary instructions.



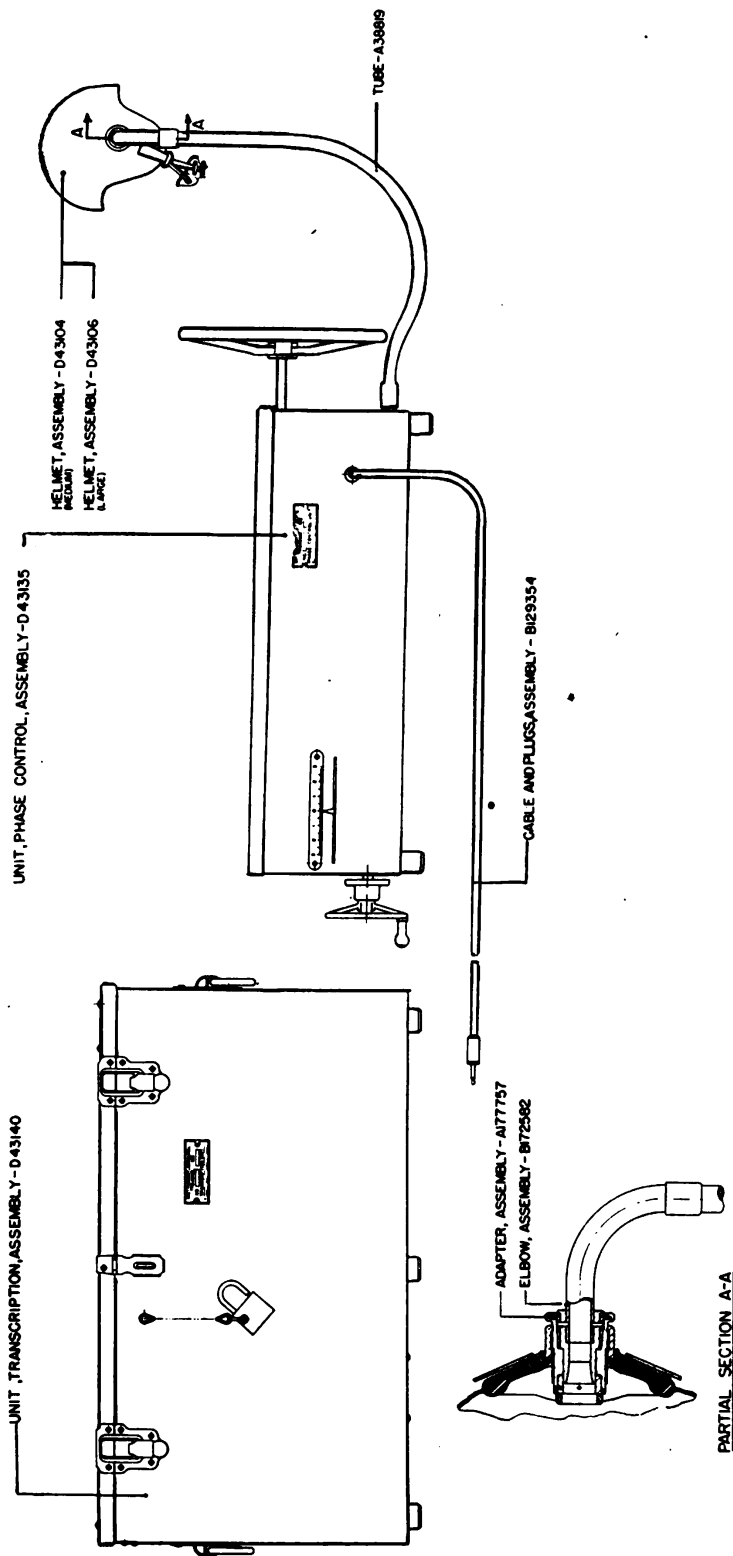


FIGURE 1.—Binaural training instrument M2—arrangement.

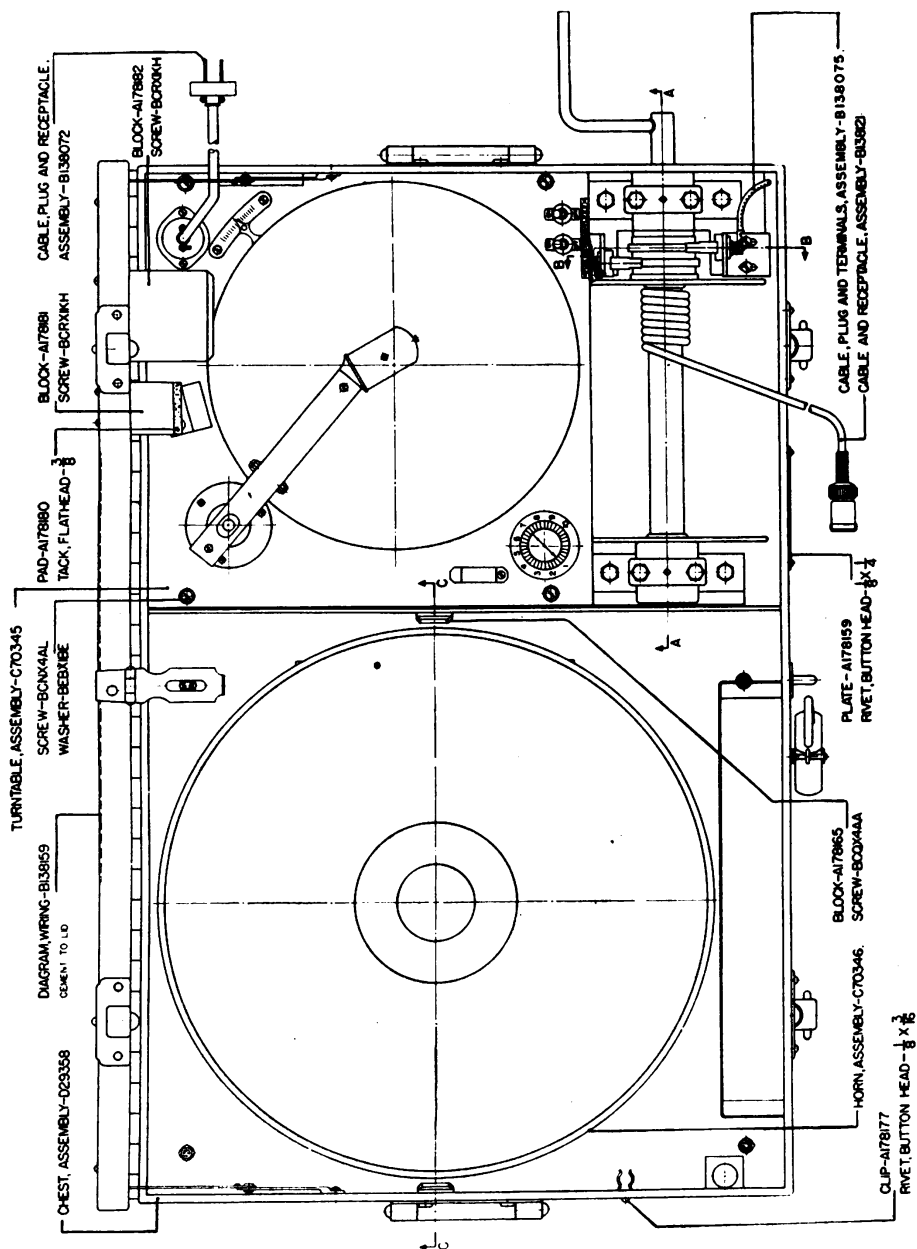


FIGURE 2.—Transcription unit assembly—plan view.

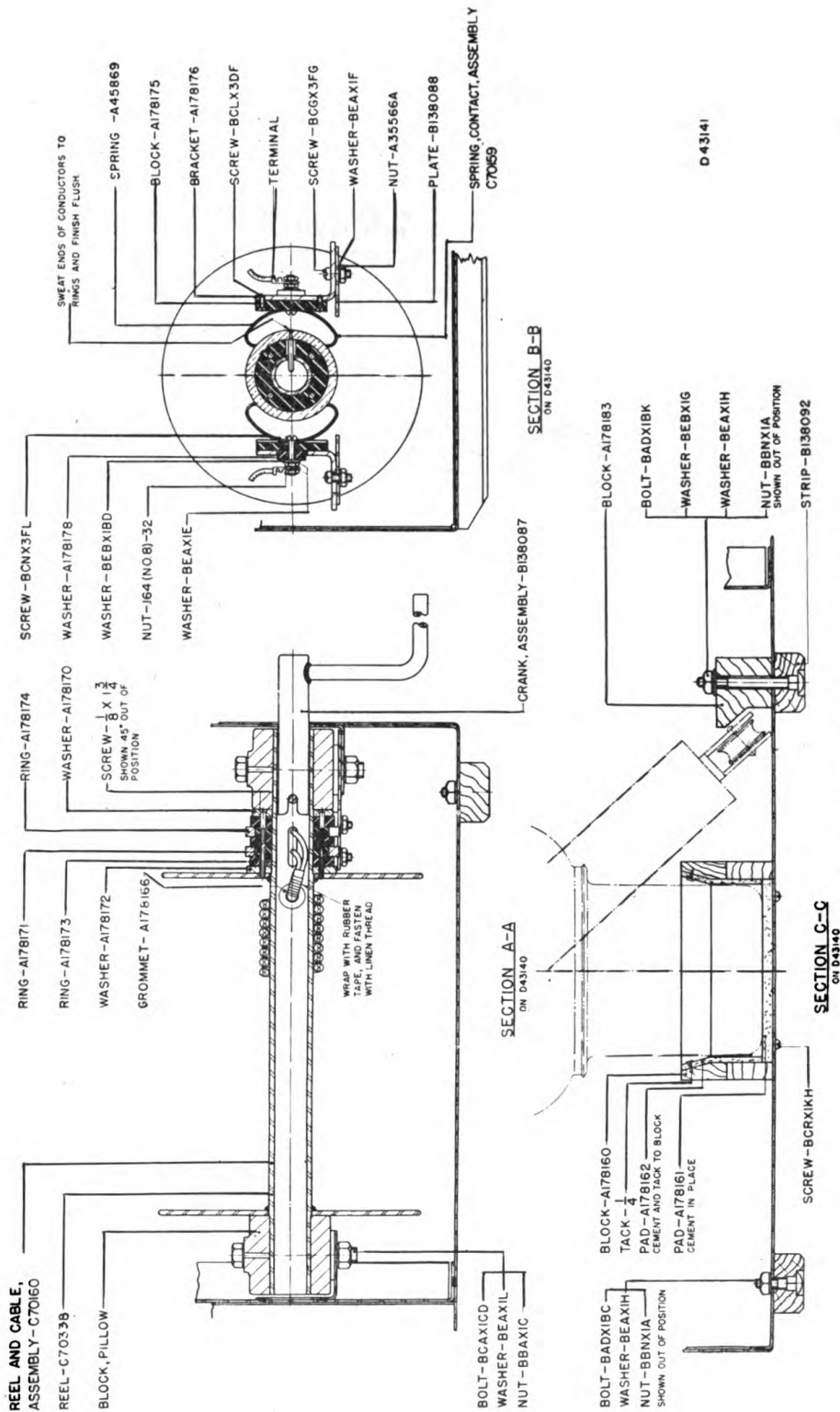
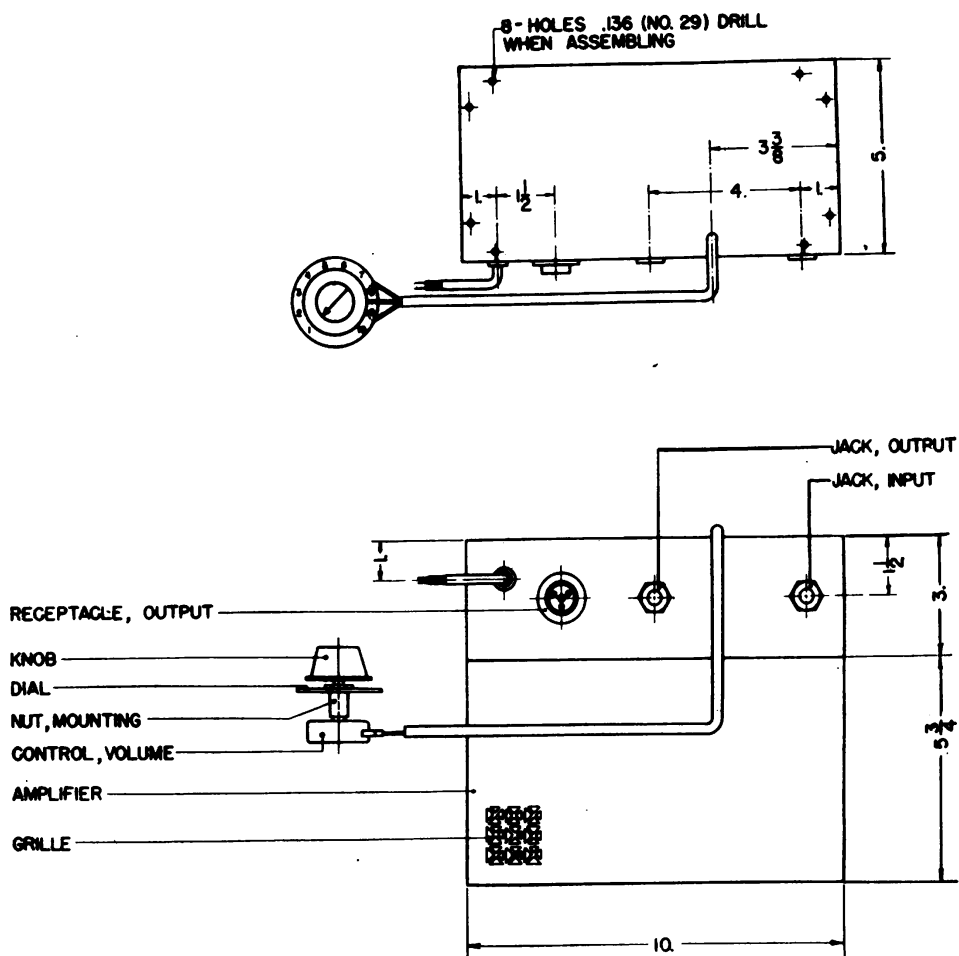


FIGURE 3.—Transcription unit—sectional views.



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FIGURE 4.—Amplifier assembly.



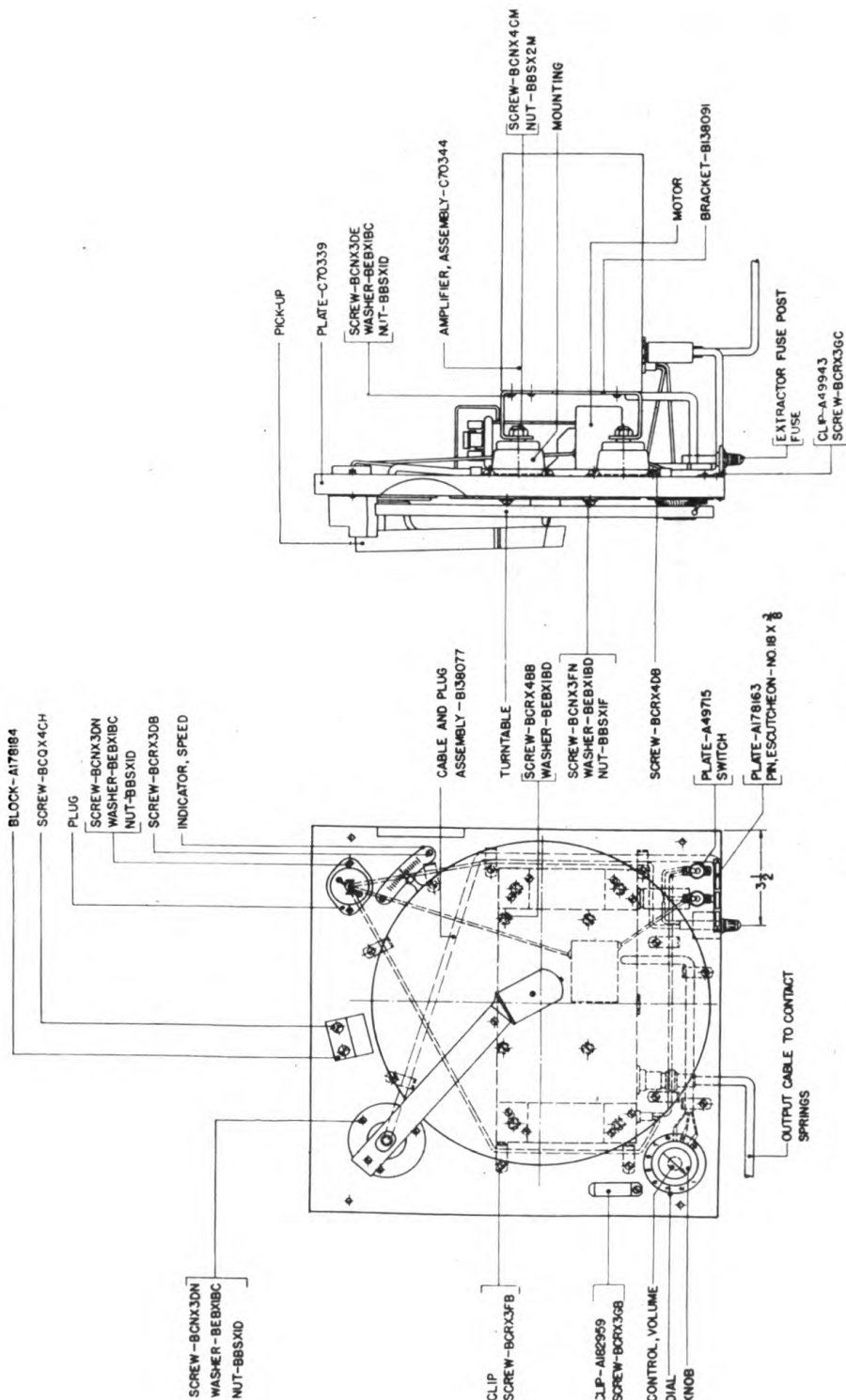


FIGURE 5.—Turntable assembly.

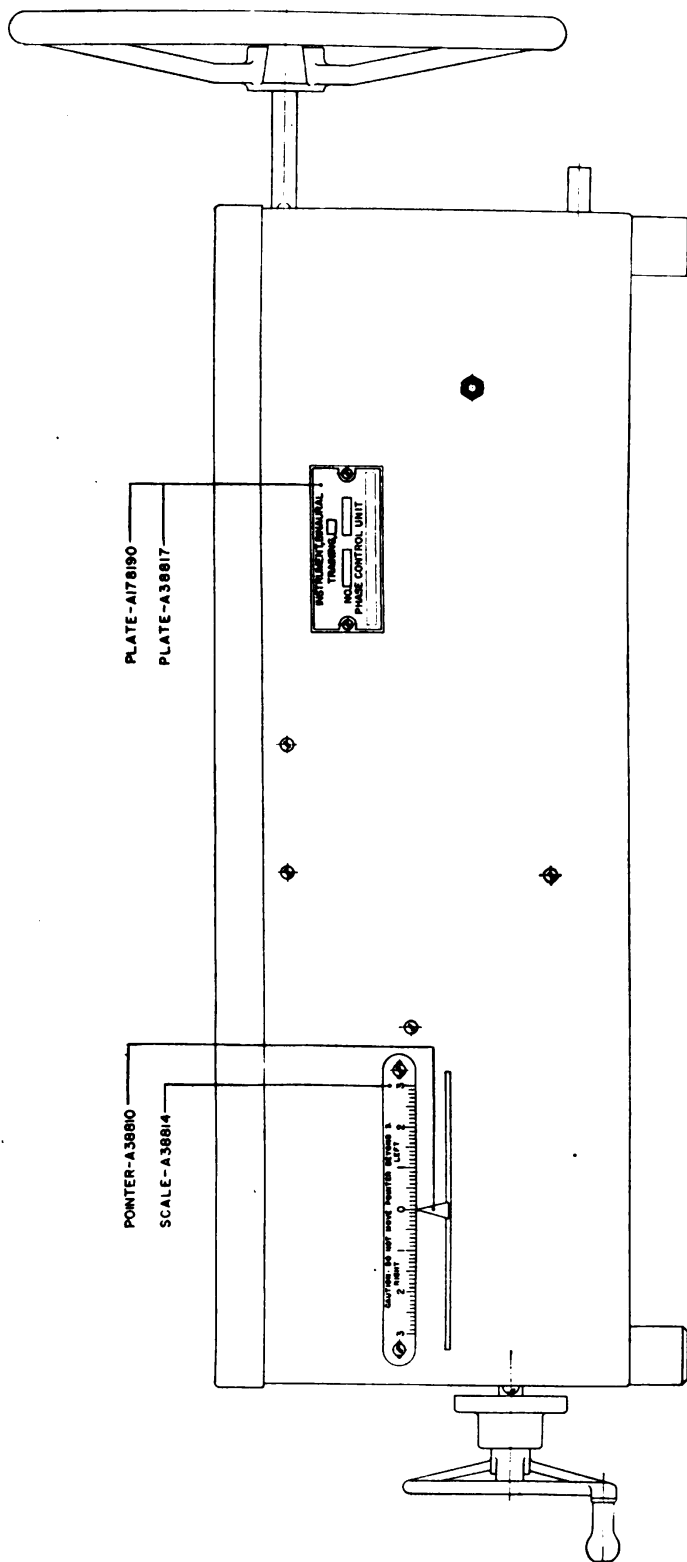
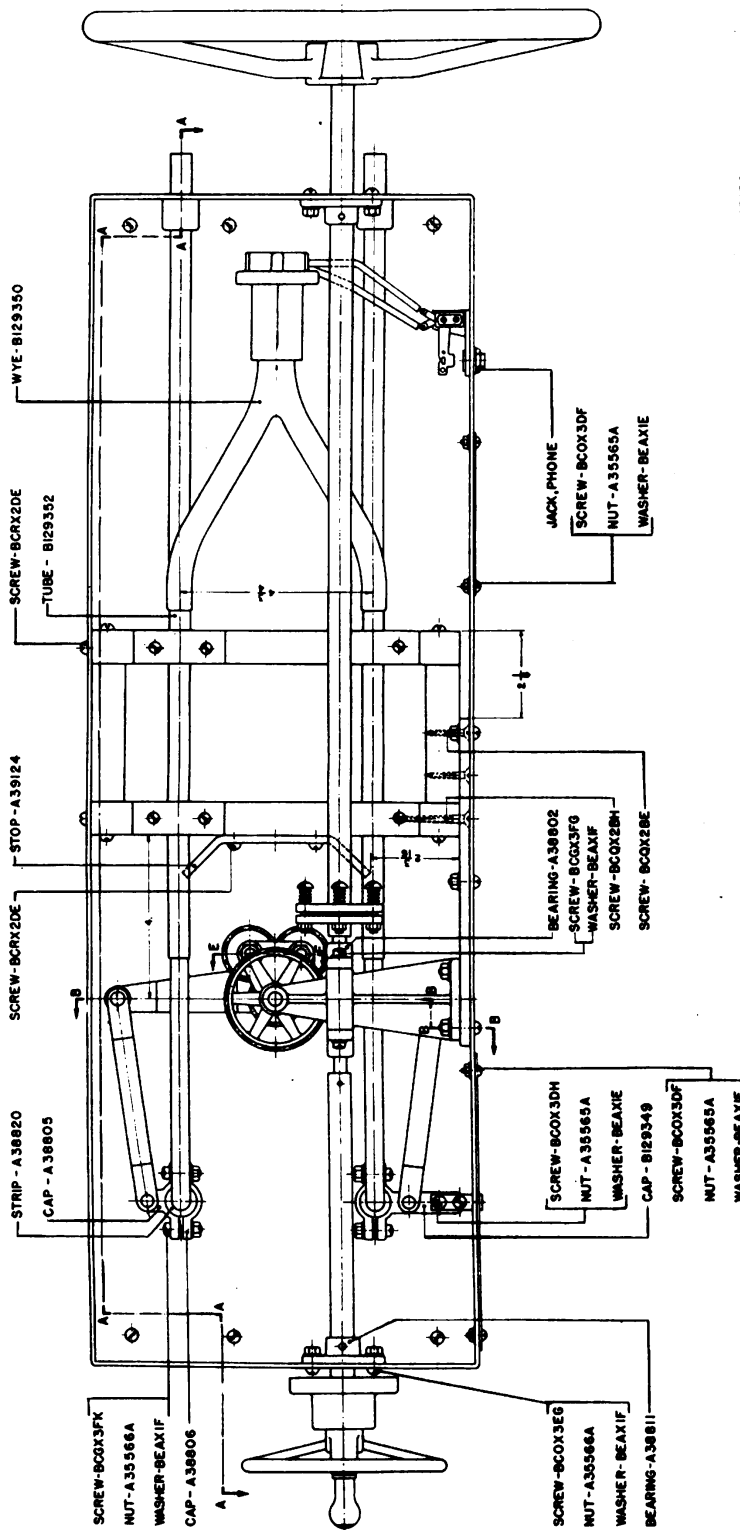


FIGURE 6.—Phase control unit assembly.



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FIGURE 7. Phase control unit, lid removed.

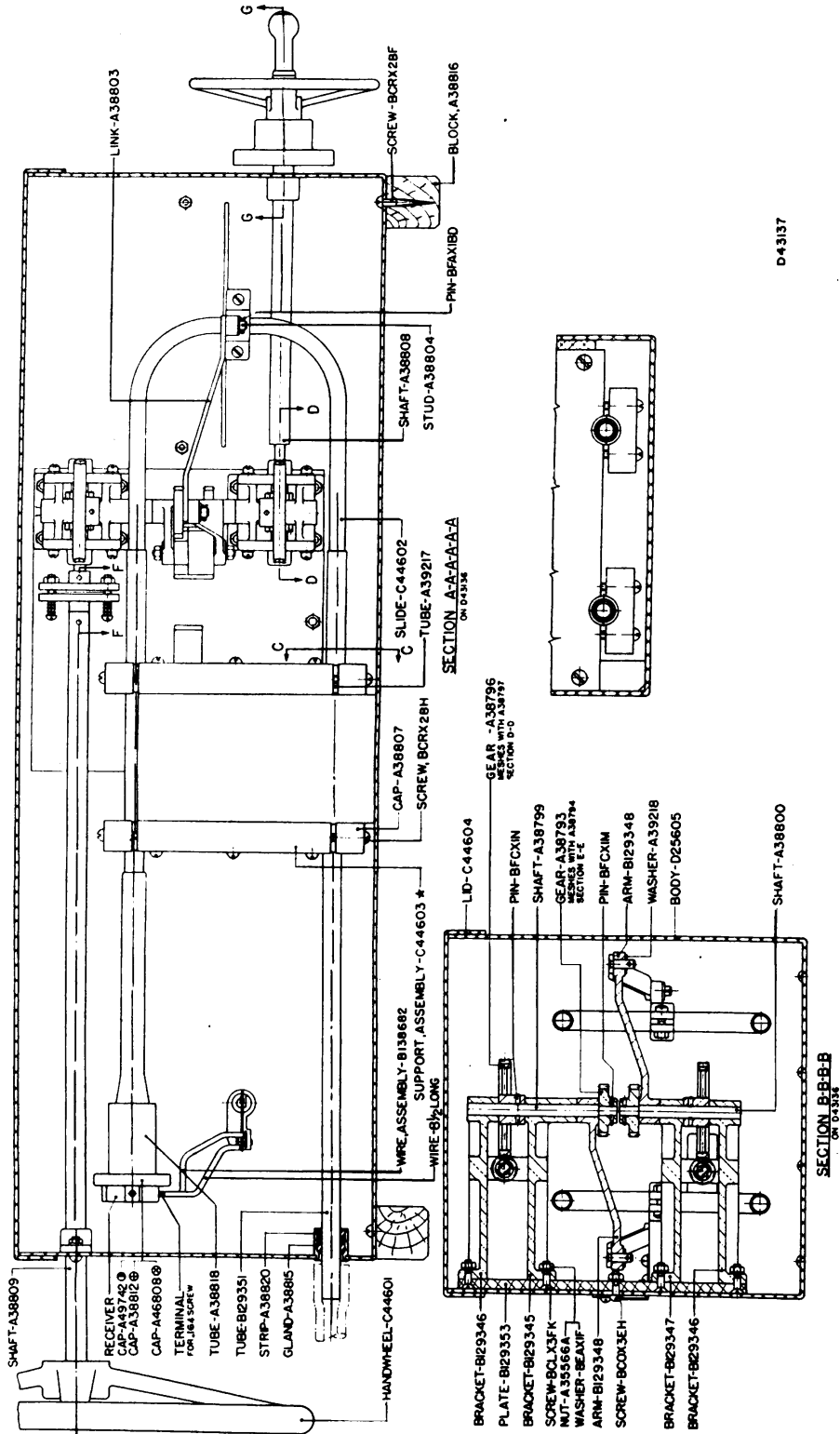
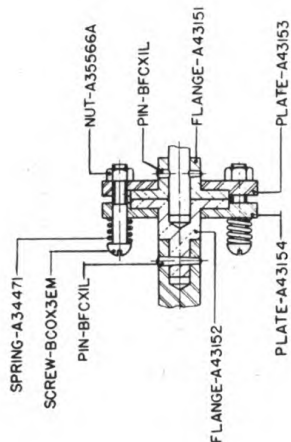


FIGURE 8.—Phase control unit—sectional views.

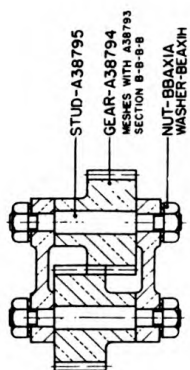
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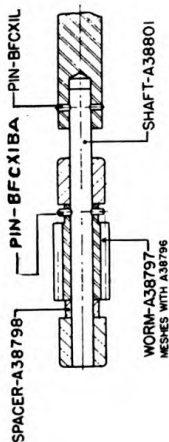
BINAURAL TRAINING INSTRUMENT M2



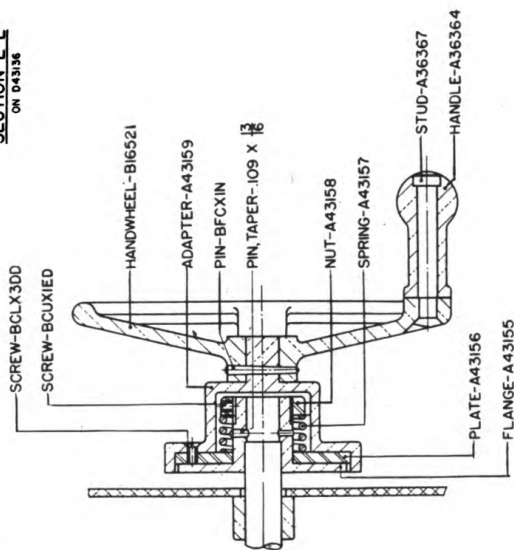
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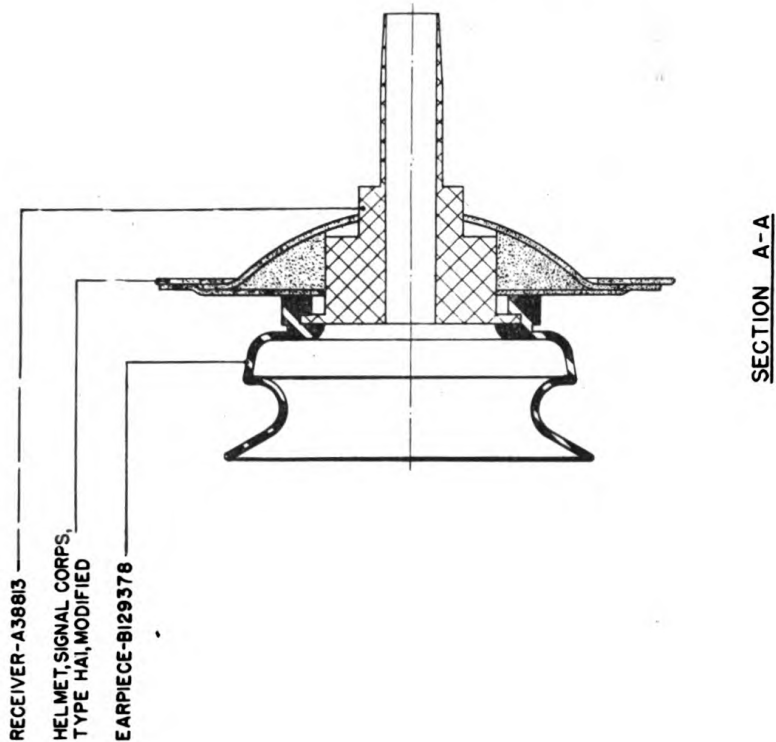
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FIGURE 9.—Phase control unit—sectional views.

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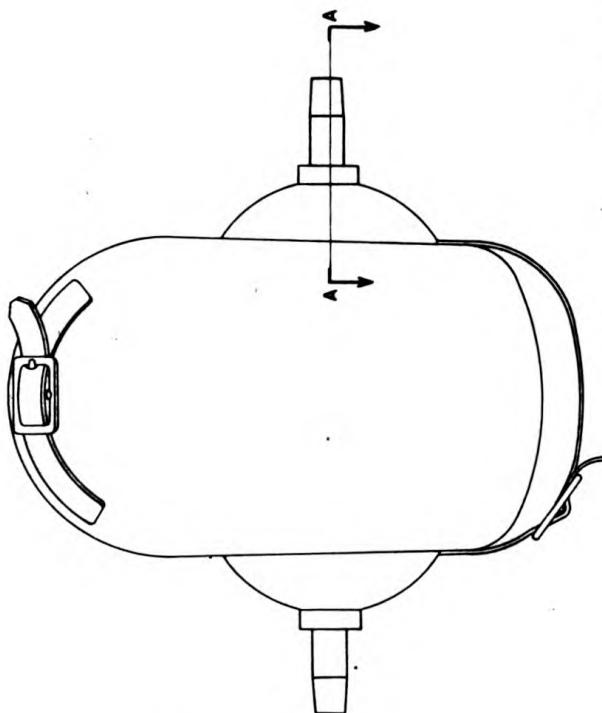


FIGURE 10.—Helmet assembly.

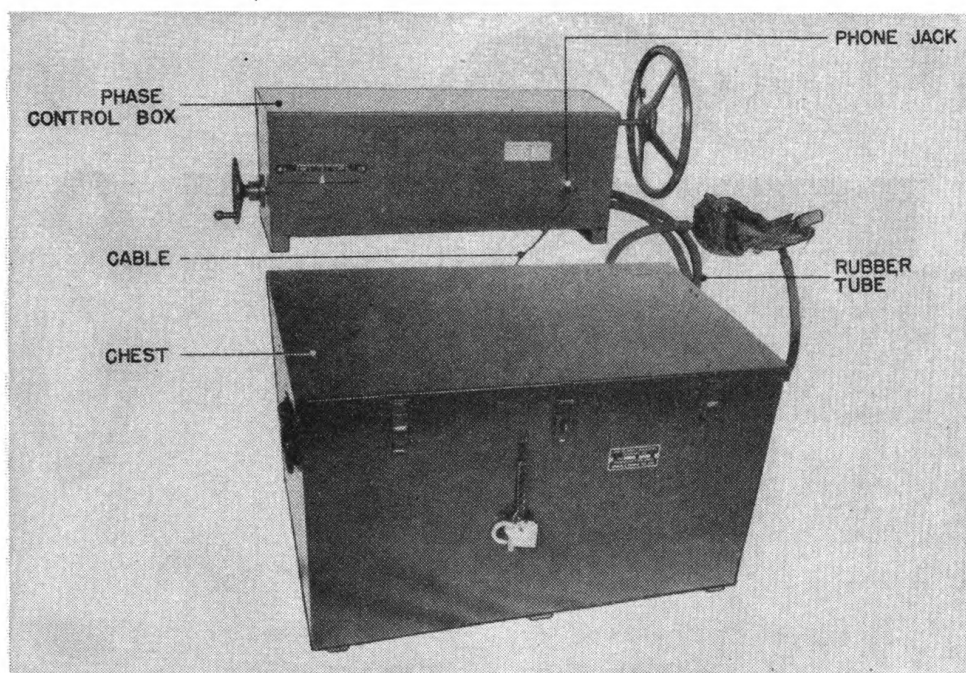


FIGURE 11.—Binaural training instrument M2.

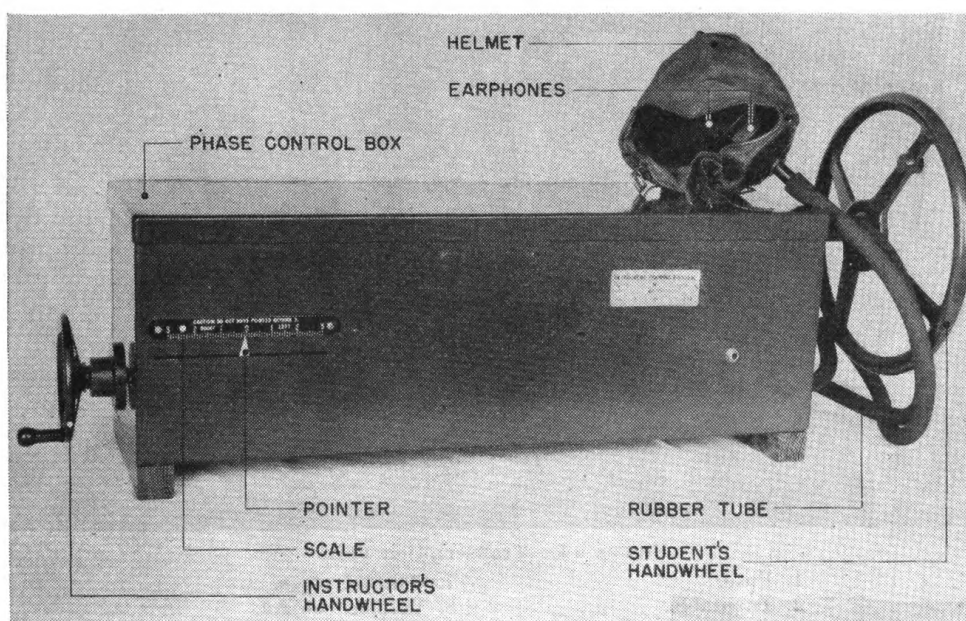


FIGURE 12.—Phase control unit.

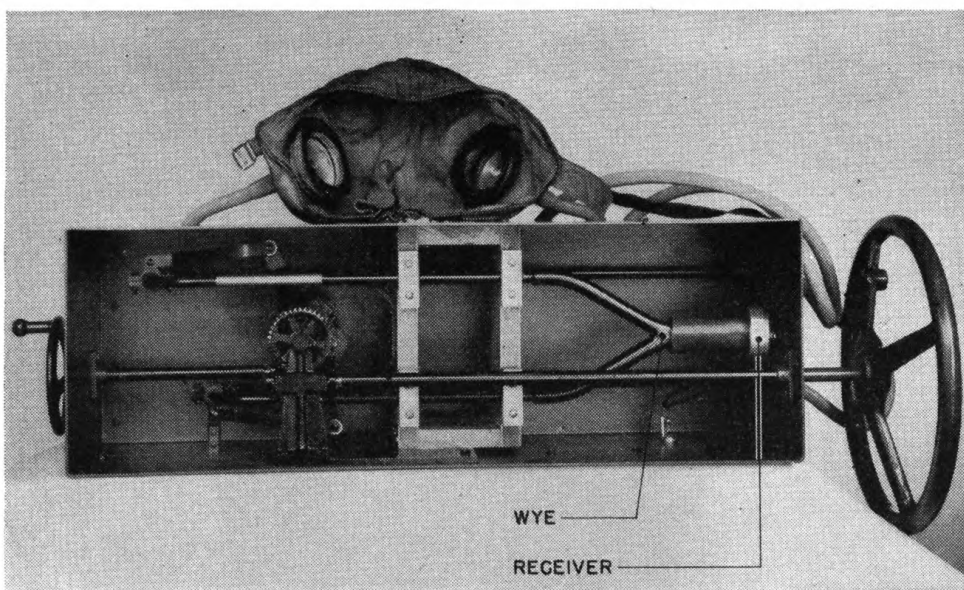


FIGURE 13.—Phase control unit, cover removed.

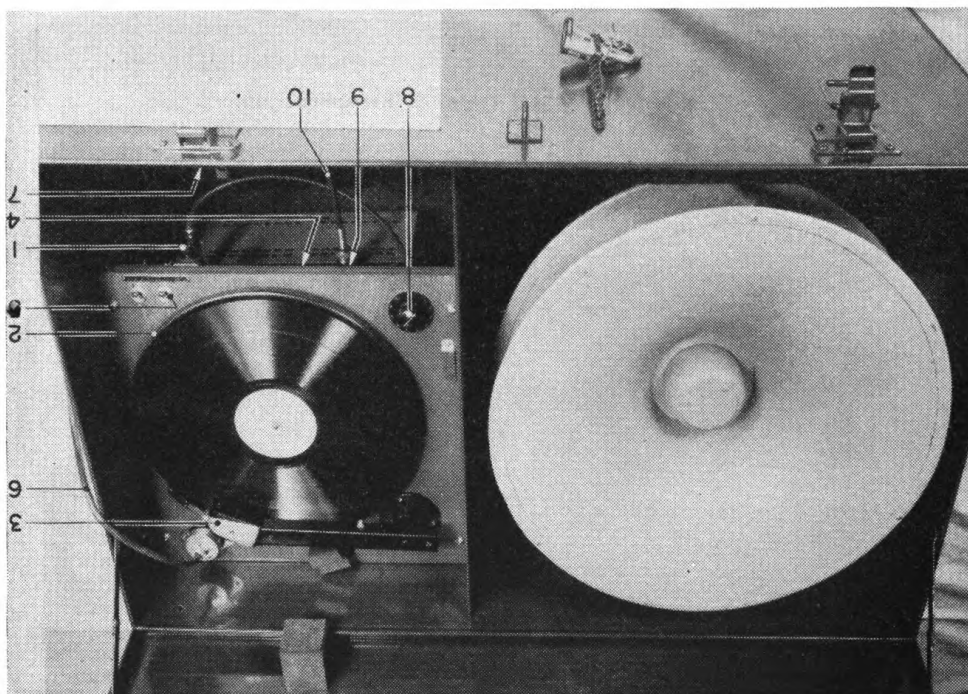


FIGURE 14.—Transcription unit.

- |                                       |                                    |
|---------------------------------------|------------------------------------|
| 1. Fuse.                              | 7. Contact rings.                  |
| 2. Turntable.                         | 8. Volume control.                 |
| 3. Pick-up.                           | 9. Plug.                           |
| 4. Phone jack on amplifier.           | 10. Cable from rings to amplifier. |
| 5. Toggle switch.                     |                                    |
| 6. Power cable to transcription unit. |                                    |



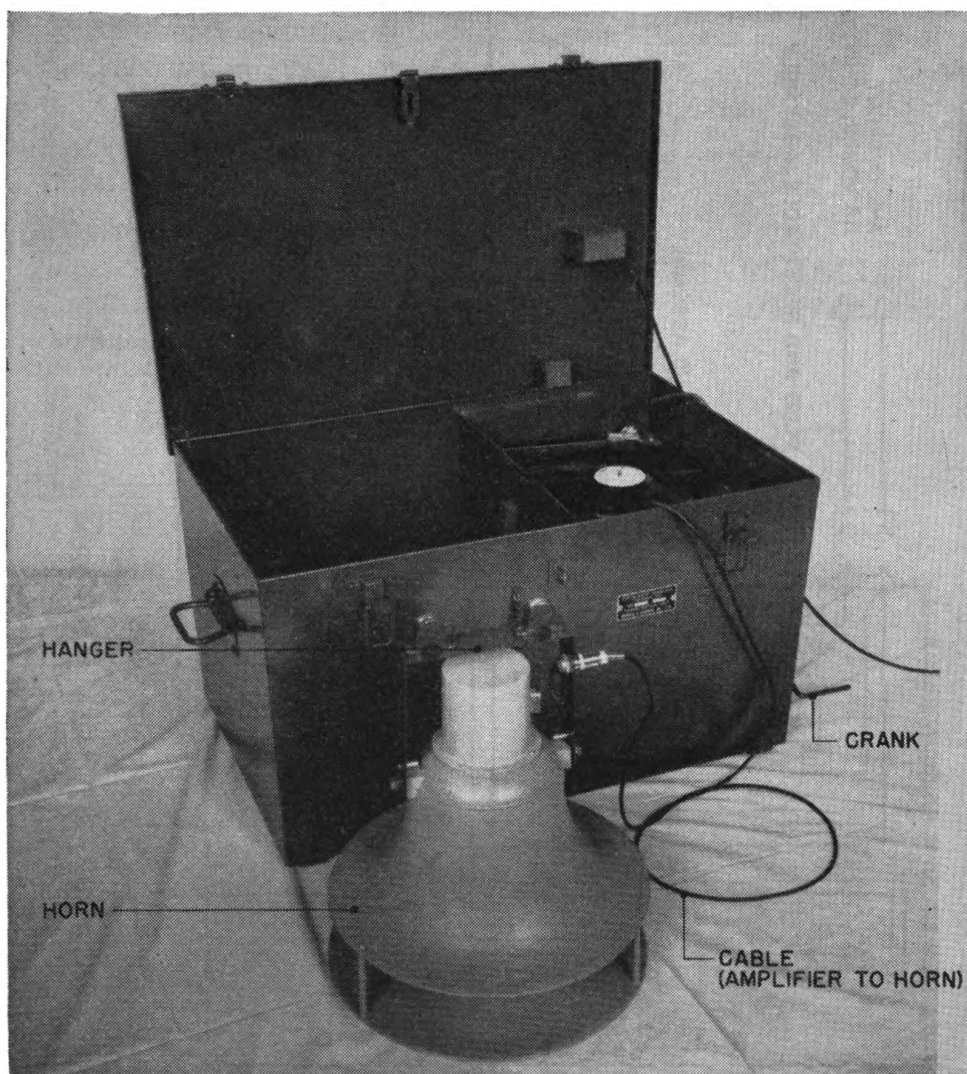


FIGURE 15.—Transcription unit and horn.

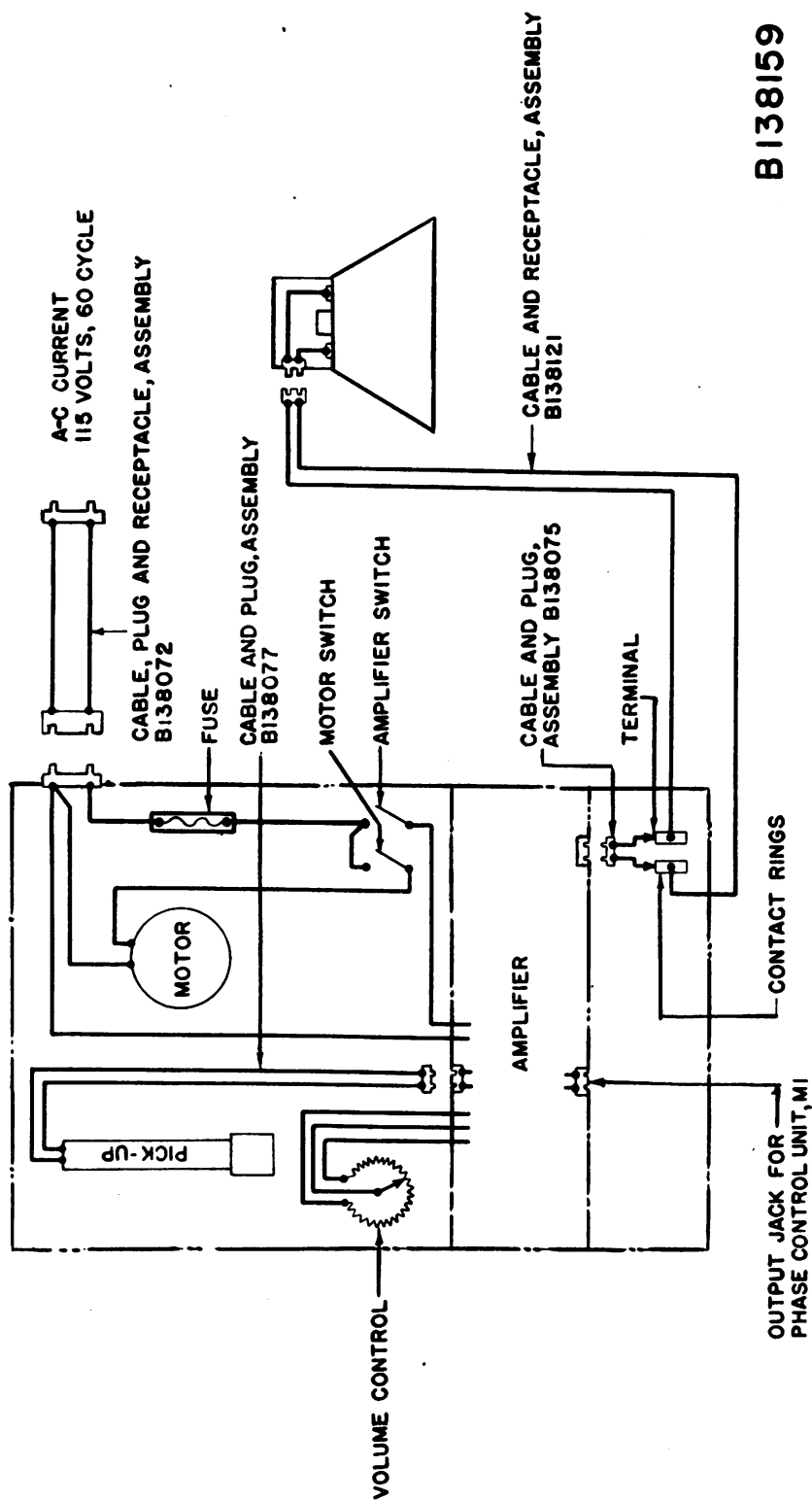


FIGURE 16.—Wiring diagram.

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BINAURAL TRAINING INSTRUMENT M2

APPENDIX

LIST OF REFERENCES

1. **Standard Nomenclature List.**

Instrument, binaural training, M2----- SNL F-198

2. **Technical Manuals.**

Ordnance maintenance, sound locator M2----- TM 9-1660

Instruction guide, sound locator M2----- TM 9-2660

Ordnance maintenance, binaural training instru-  
ments M1 and M2----- TM 9-1662

[A. G. 062.11 (1-27-41).]

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*Chief of Staff.*

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